

SUPPLEMENTAL SPECIFICATION

WSF 002

M/V KALEETAN

DOCKSIDE PRESERVATION

GENERAL CONSTRUCTION REQUIREMENTS

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This Attachment contains general requirements that apply to all Contract Work unless superceded by more detailed specification requirements stated in specification Work Items.

1. GENERAL

- . The Vessel is not intended to be in ABS Class. However, the Technical Specifications may include references to ABS requirements. Where designs, processes, procedures and installation requirements are referred to ABS rules, the Contractor shall adhere to the requirements of the applicable ABS rules but is not required to obtain ABS approval, nor required to have ABS onboard inspection. Certain materials and equipment are indicated to be “certified” by ABS. Where the term “certification” is used, the Contractor shall obtain ABS approval and “Certification” for the noted material or equipment.
- . The Contractor shall remove and relocate all interferences associated with all Work performed as part of this Contract. Equipment that cannot be replaced in its original location shall be relocated as approved by the WSF Representative.
- . The equipment installed by the Contractor shall be located, supported, and connected so as to permit ready and safe access to all parts and components required for operation, inspection, service, maintenance and repair without disturbance of other structure or equipment.
- . Unless otherwise specified, the minimum headroom in new or modified interior spaces shall be 7 feet 0 inches. The WSF Representative may approve deviations from this requirement on a case basis where this minimum headroom requirement is demonstrably impractical. Special care and attention shall be paid to the dimensioning of ventilation ducting, wireways, and pipe runs, and the placement of new or replaced ventilation fans, new or replaced wireways, and new or replaced piping systems in order to avoid reducing the clearance. Auto Deck overhead clearance shall be maintained as indicated on the Vessel.
- . The Contractor is cautioned to pay particular attention to the design and construction of any new or modified portions of the Vessel in order to minimize vibrations and noise, both structural and airborne.
- . The Engineer’s Operating Station (EOS) and adjacent Engineer’s Dayroom are continuously manned spaces. Sound attenuation within these spaces shall not be compromised. The Contractor shall pay particular attention to providing an installation that minimizes sound paths between the Engine Rooms and the interior of the EOS and Dayroom.
- . The Contractor shall be responsible for locating and correcting unsatisfactory noise conditions arising during tests or trials, or subsequently during the

warranty period, which can be directly attributed to the design, construction, or workmanship of those elements of the construction and installation accomplished by the Contractor.

. All fasteners used in weather areas shall be 316 stainless, grades 5 or better.

. VESSEL MOTION

0. Unless otherwise specified, all machinery, structure, foundations, and outfit is to be designed to withstand, and to properly function given the resultant dynamic forces from the following conditions of service environment:

-) Permanent list of 10°.
-) Permanent trim of 5°.
-) Double amplitude roll of 30° in a period of 8 seconds.
-) Double amplitude pitch of 10° in a period of 4 seconds.

. ISOLATION

0. The Contractor shall provide all labor, materials, and equipment to dielectrically and vibration isolate all new, relocated, and modified equipment to:

-) meet or exceed the original isolation for relocated and modified equipment and;
-) meet isolation requirements of the manufacturer for all new equipment installed by this Technical Specification.

0. All isolation details shall be documented in Final As built drawings.

. PENETRATIONS OF STRUCTURAL MEMBERS

0. Penetrations of structural members (beams, bulkheads, girders, etc.) for piping, ducting, cableways, or otherwise shall be kept to an absolute minimum, but where required, penetrations shall have compensation. Existing penetration holes or lightening holes shall be used whenever possible. Holes may be made in the web of a member only. Holes, scallops or other weakening of flanges in new or existing structure is not permitted under any circumstances.

0. All requests for penetrations through structural members not detailed in the Contract Guidance Drawings must be submitted to (along with sketches and calculations, as applicable), and approved, in writing, by the WSF Representative.

0. If a structural member has to be penetrated other than those shown on the Contract Guidance Drawings, or if an existing structural member penetration is modified in any way during the course of the Work, the construction drawings must depict the penetration with a detail of the

penetration including cut size, location, and any strengthening in way of the cut. Location of penetrations and openings in structure, and associated stress concentration relief, shall be guided by Section 18 of Chapter 5 of the SNAME publication *Ship Design and Construction, 1969 Edition*. Calculations of the strength of the penetrated member shall accompany the drawing or sketch for penetrations and openings that do not conform to the above. This pertains to enlarging those openings shown on the Contract Guidance Drawings as well as to new openings.

0. The Contractor shall close-up all unused penetrations resulting from removed or rerouted piping, ventilation, and cableways and as required by Regulation for the required classification of the boundary. Existing “collared” penetrations through structural members need not be inserted unless the member forms part of a classified boundary. Penetrations, strengthening, and close-up shall be the responsibility of the Contractor.

2. ARRANGMENT

ACCESS FOR MAINTENANCE

0. The machinery and equipment installed by the Contractor shall be located, supported, and connected so as to permit ready and safe access to all parts and components required for operation, inspection, service, maintenance and repair without disturbance of other structure or equipment. . The ability to quickly access RTD or thermocouple sensors without the necessity of cutting the cables shall be incorporated in the installation.
0. Access shall be by means of permanent ladders, walkways, platforms, doors, manholes, scuttles and/or bolted plates. Battens and gratings in storerooms and other spaces, and protective casings around pipes, shall be made readily removable. Ladders shall be located in line with access openings.
0. All newly constructed or modified tanks shall be provided with access for cleaning and maintenance. Tank accesses shall be sized to allow easy visual inspection and a means of entry for maintenance, either through handholes or manholes, based on the tank size. All accesses shall be provided with proper gaskets, cover plates and corrosion resistant closure fasteners. Unless otherwise shown on drawings, provide 3/4 inch piping, valve, and plug for draining.
0. Restriction of existing access openings or soft patches by pipes, wireways, ventilation, maintenance pull spaces, valves, and the like is not permitted.
0. All trunks, casings and enclosures shall be large enough to facilitate

servicing of piping, manifolds and similar appurtenances which may be contained in or pass through the space.

0. To facilitate inspection and maintenance of equipment having removable heads/sections or other major parts (including tube or tube bundle withdrawal), piping systems shall be designed and installed to permit access by disassembly of the equipment system's mechanical connections only. If this requirement is not possible, suitable piping takedown joints shall be provided. Heat exchanger tube bundle withdrawal zones shall be kept free of all other interference.

3. STRUCTURAL REQUIREMENTS

INTEGRITY

0. Workmanship shall ensure that the requisite hull integrity is obtained, that exposed surfaces are smooth, and that proper fit and alignment are accomplished and maintained. Care shall be exercised to minimize stress concentrations and all structure shall be neatly fitted and finished. Cuts in structures and procedures for stress concentration relief shall be guided by USCG NVIC-7-68 (or current version).
0. The exterior of all new and replaced portions of the Vehicle Decks, Machinery Casings, Passenger Decks, weather decks, deckhouses, housetops, and associated weather boundary bulkheads shall be proven weather tight.
0. All Passenger and Crew Restroom perimeter bulkheads shall be proven fume tight unless otherwise specified.
0. New or repaired shell plating and new or modified watertight bulkheads shall be demonstrated to be watertight by air testing, or hose testing.

MATERIAL

1. All steel shall be new and, unless otherwise specified, shall be certified by the steel supplier to meet ABS Grade A or B as required for the service intended. The mill certification for all plate, structural shapes, and other structural material requiring certifications to be used in/on the Vessel shall be provided. A copy of the mill certification for all plate to be used in the Vessel shall be provided to the WSF Representative prior to use of that steel on the Vessel. ABS Certification for all plates and structural shapes to be used on the Vessel need not be obtained. However, the mill certification of physical and chemical properties that meet ABS criteria is required.
0. Each plate and shape shall be marked with the certification number. The certification number shall be kept visible on the unused portion of the plate or shape until consumed.

0. All new steel shall be wheel-abraded or grit blasted to a SSPC SP-10, Near-White Blast Cleaning, and immediately primed with weld-through primer that is compatible with the coating systems used on the Vessel. Where a sheet steel gauge is specified it shall be USS for plain steel and USSG for galvanized material. All temporary assembly clips and temporary padeyes shall be removed and the attachment welds ground smooth and/or gouges welded flush and ground smooth.
0. Workmanship shall meet SNAME standards of quality to ensure that the requisite hull integrity is obtained, that exposed surfaces are smooth, and that proper fit and alignment are accomplished and maintained. Care shall be exercised to minimize stress concentrations and all structure shall be neatly fitted and finished. Cuts in structures and procedures for stress concentration relief shall be guided by SNAME "Ship Design and Construction", 1969 Edition, Chapter IV, Section 18.
2. Pop rivets shall not be used in place of threaded fasteners without the prior written approval of the WSF Representative, or are specifically called for in a Work Item. All exterior fasteners shall be Type 316 stainless steel. All interior fasteners shall be corrosion resistant, grade 5 or better. All nuts shall be Nylok or equal, except for general lighting and main cableways.

ACCESS CUTOUTS

0. Provide shipping access cuts as required to remove, install, or reinstall equipment and items. Provide temporary shoring and stiffening as required to safely accommodate equipment removal and reinstallation, as well as for any other load handling operations that may be required. Provide temporary lifting padeyes as necessary to assist in removal, installation, and reinstallation of equipment, components, and machinery.
0. Submit three (3) copies sketches showing proposed access cutouts, temporary shoring and stiffening, and temporary padeye arrangements to the WSF Representative for review prior to accomplishment.

NOTE: WSF does not pre-suppose the Contractor's methods of getting machinery, equipment, and material to and/or from the installation site nor the attendant need for access cutouts.
0. Restrictions of access openings or soft patch areas by pipes, valves, wireways, or other interferences are not permitted.
0. Remove deck and bulkhead sections as required to remove large machinery and components and to install or reinstall new and/or repaired machinery and components. The corners of all access cuts shall be rounded to a minimum radius of six (6) inches.
0. Mark and save sections of plating and associated stiffeners removed

for reinstallation. Ensure that the marking provides that removed sections are returned to their original location and orientation.

0. After the Contractor is assured that all reinstallations, new installations, relocations, and modifications which require the movement of heavy objects have been completed, remove all previously placed shoring, stiffening, padeyes, and other similar items which were provided to assist in the task. Temporary padeyes may remain in place if they are tested and labeled with test weight and date and do not interfere with Vessel operation or maintenance. Reinstall all removed bulkhead and deck sections, including beams, girders, and stiffeners. Reinstalled structure shall satisfy the tightness and strength criteria of the original structure unless current laws, rules, or regulations, whether local, State, or Federal impose more stringent requirements, in which case the more stringent requirements shall be met. Reinstalled structure shall be appropriately tested to ensure that it meets current criteria for strength and tightness. Butts and joints in temporary access cuts shall be tested in accordance with this Technical Specification to prove that the integrity of the structure has been restored.
0. The Contractor shall repair, at his sole expense, any damage or deformation of the hull structure, beams, girders, stiffeners, or other similar items that occur as the result of load handling operations or any aspect of the Work.

FOUNDATIONS

0. The Contractor shall design, provide and install new foundations for all new, modified, and relocated machinery and equipment. The foundations shall have the strength and stiffness required to support and maintain alignment of mounted machinery or equipment in its operational mode.
0. Loading to be considered in the design of foundations shall include:
 -) Dry weight of equipment
 -) Weight of fluids
 -) Dynamic loading induced by equipment in operation
 -) Weights of ancillary components and systems, piping, wiring, etc.
 -) Vessel motion (see above)
0. Distribute machinery or equipment loading to the Vessel's primary structure. Provide additional structural members such as headers and chocks as required. All foundations shall be designed to attach to primary structure. Deck gratings and walkways are not considered primary structure.

- 0. Provide for alignment and other special requirements of the mounted machinery or equipment.
- 0. Permit access to machinery or equipment for servicing and maintenance and avoid inaccessible areas or pockets in the foundation and framing. Switchboard, Power Panel, ABT, motor starters, etc. doors shall allow for their doors to open a minimum of 90°.
- 0. Where machinery, such as a switchboard, is supplied bolted to a substantial steel base, the base may be welded to the foundation provided the machinery (including future replacements) can be aligned after welding the base and foundation together.
- 0. Foundations for machinery containing liquids shall have containment of dimensions and construction as specified in Work Items descriptions in order to contain any leakage. Each containment shall be provided with drain connections.
- 0. The Contractor shall provide foundations as required for all machinery and equipment modified or relocated in way of new and modified bulkheads.
- 0. All bolting, washers, and nuts used in foundations shall be corrosion resistant, grade 5 or better, and nuts shall have Nylok or equal inserts.

STEEL FAIRNESS CRITERIA

0. The following table gives the maximum acceptable depth of unfairness of newly installed plating between frames, stiffeners, or deck beams. Depth of unfairness is measured by placing a straight edge, three (3) times the frame, stiffener, or beam spacing in length, across the plating between frames, stiffeners, or deck beams. The depth of the maximum allowed hump or hollow is then measured from the straight edge thus applied.

STEEL PLATE FAIRNESS CRITERIA

STIFFENER SPACING	MISCELLANEOUS INTERIOR BULKHEADS, DECK HOUSE SIDES & TOPS, MISCELLANEOUS FLATS				ALL SHELL & DECK PLATING INCLUDING F.P.K. & GUARD, CURTAIN PLATING, VEHICLE, PASSENGER & TEXAS DECKS & MAIN BULKHEADS				
	7.65 # ($\frac{3}{16}$ ")	10.2 # ($\frac{1}{4}$ ")	12.75 # ($\frac{5}{16}$ ")	15.3 # ($\frac{3}{8}$ ")	7.65 # ($\frac{3}{16}$ ")	10.2 # ($\frac{1}{4}$ ")	12.75 # ($\frac{5}{16}$ ")	15.3 # ($\frac{3}{8}$ ")	20.4 # ($\frac{1}{2}$ ")
28"	$\frac{3}{8}$ "	$\frac{3}{8}$ "	$\frac{3}{8}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "
26"	$\frac{3}{8}$ "	$\frac{3}{8}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "
24"	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{1}{4}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{1}{4}$ "
22"	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{1}{4}$ "	$\frac{1}{4}$ "	$\frac{5}{16}$ "	$\frac{5}{16}$ "	$\frac{1}{4}$ "	$\frac{1}{4}$ "	-
20"	$\frac{5}{16}$ "	$\frac{1}{4}$ "	$\frac{1}{4}$ "	$\frac{3}{16}$ "	$\frac{1}{4}$ "	$\frac{1}{4}$ "	$\frac{1}{4}$ "	$\frac{3}{16}$ "	-
18"	$\frac{1}{4}$ "	$\frac{1}{4}$ "	$\frac{3}{16}$ "	$\frac{3}{16}$ "	$\frac{1}{4}$ "	$\frac{3}{16}$ "	$\frac{3}{16}$ "	$\frac{3}{16}$ "	-
14"	$\frac{3}{16}$ "	$\frac{3}{16}$ "	$\frac{3}{16}$ "	-	$\frac{3}{16}$ "	$\frac{3}{16}$ "	$\frac{3}{16}$ "	-	-

0. During deck plating installation, or other structural work, the Contractor shall exercise great care to assure that all surfaces are free from "oil can" deflection. Should "oil can" deflection occur, the Contractor shall remove such deflection by heat shrinking or mechanical displacement.
0. Where preventive measures are insufficient to control distortion and fairness tolerances are exceeded, straightening shall be employed to

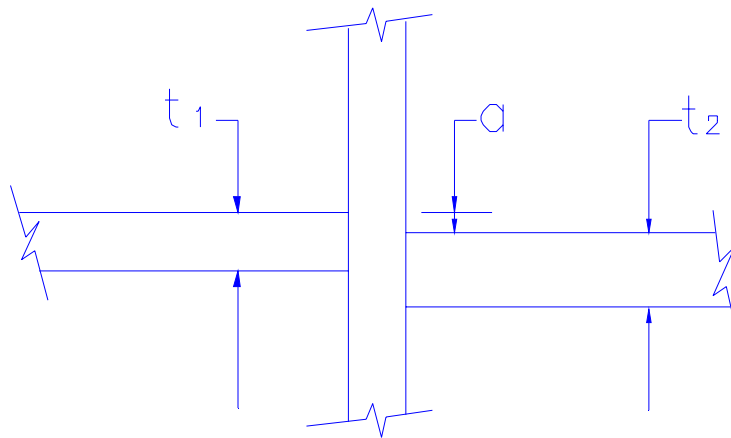
the minimum extent necessary to bring the plating within the tolerances specified.

BEAM STRAIGHTNESS CRITERIA

3. Frame, beam and stiffener bows in all structure installed in accordance with the Technical Specifications shall be corrected when it varies plus or minus from the designed or molded line in excess of $\frac{3}{8}$ " or the following, whichever is less:
 0. $\text{Span (feet)} / (\text{Depth (inches)} \times 4) = \text{Tolerance (inches)}$
 0. Span is the distance between the fixed ends at support structure, and Depth is the depth of a stiffening member measured from the underside of the flange. The measurement shall be taken from the most distorted position of the web.

ALIGNMENT CRITERIA (INTERCOSTAL STRUCTURE)

0. Structural components installed in accordance with the Technical Specification shall be aligned according to the following ASTM F 1053-87 criteria:



a = allowable offset ; t = thickness; $t_1 \leq t_2$

For principal longitudinal strength members:

$$a \leq \frac{1}{3} t_1$$

For other structural members:

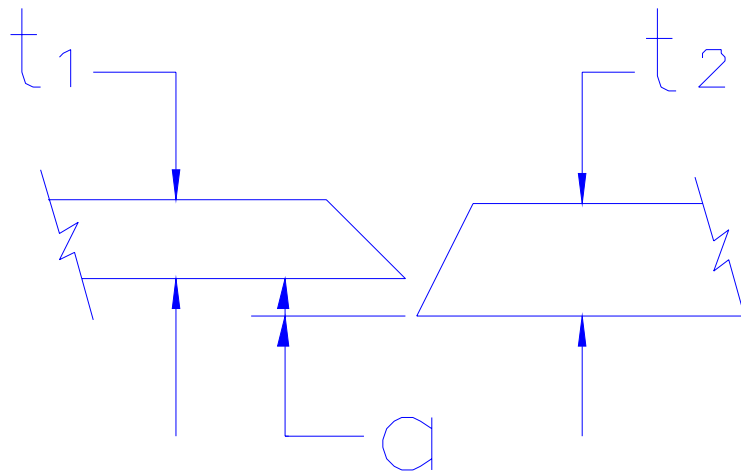
$$a \leq \frac{1}{2} t_1$$

0. The alignment criteria applies to all structural alignments except butt joints including but not limited to: brackets; alignment of intercostal stiffeners, beams and girders; bulkheads, stanchions and pillars above

or below a deck, or on opposite sides of a bulkhead, or the web of a beam or girder. Pipe stanchions of different diameter, and stanchions constructed from I or H sections, will be given special consideration.

ALIGNMENT CRITERIA (BUTT JOINTS)

0. Every effort should be made in assembly of structure to obtain 100% alignment on the molded line side of the members being joined, as shown below:
0. The maximum allowable offset tolerance shall be 15% of the thickness of the thinner member being joined (ASTM F 1053 criteria), as shown below:



$$a = \text{allowable offset} \leq (0.15) t_1; \quad t = \text{thickness}; \quad t_1 \leq t_2$$

WELDING

0. All welding/welder qualifications and welding procedures shall be the responsibility of the Contractor, and satisfy the requirements of 46 CFR 57, including ASME BPVC Section IX and shall conform to the requirements of Parts 2 and 3 of the ABS “Rules for Building and Classing Steel Vessels” (latest edition), or “Rules for Building and Classing Aluminum Vessels” (latest edition), Section 30.
0. Welders shall be certified through the performance of tests required by 46 CFR 57, ASME BPVC Section IX, or ABS tests Q1 through Q4, Table 2/3C.1 (for steel) or ABS tests Q1, Q2, Q4, Q5, & Table 30.6 (for aluminum), as applicable to the type of welding being performed by each individual.
4. No welder shall be assigned to a welding task aboard the Vessel, or to any structure or component being fabricated off the Vessel for future installation in or on the Vessel, until the WSF Representative has been

provided with valid proof of current qualification. Should any welder's certification expire, for any reason, at any time during the Contract period, that welder shall be immediately removed from the Work and shall not be re-employed on the Vessel, or its structure or components, until such time as re-certification is obtained and documented to the satisfaction of the WSF Representative and the appropriate Authoritative Agency. The WSF Representative reserves the right to request and review any welder's certification, at any time, during the performance of the Work.

0. The Contractor is wholly responsible for developing all welding procedures and plate and shape preparation procedures to be used during the performance of the Contract and for ensuring compliance with the requirements of ABS and other cognizant Authoritative Agencies. The welding procedure, welder qualification and welder certification requirements outlined in this Work Item of the Technical Specification are applicable to, and form a part of every Work Item of this Technical Specification which may require the utilization of welding and welders.
0. Accomplish a 100% non-destructive testing (NDT) inspection of all new watertight bulkhead welds in accordance with the Contractor's approved procedures. All non-destructive weld testing shall be done in accordance with the ABS rules for Non-Destructive Inspection of Hull Welds (latest edition), using Class B weld criteria and this specification.
0. The American Welding Society's "Guide for Steel Hull Welding" will be used as a standard for visually inspecting the welding and fabrication workmanship.
0. Assembly welds shall be neat in appearance with all slag and spatter removed.

4. ELECTRICAL INSTALLATION

GENERAL

0. Connection box space provided by the Contractor for connection of power cables to all equipment shall provide sufficient space to allow use of Contractor supplied cable and heat shrink boot seals inside the connection boxes. All new or relocated equipment susceptible to, or producing, vibration shall be fitted with vibration isolating mounts.
0. Equipment requiring or specified to have replaceable air filters shall use a common filter size and style to the maximum extent possible. Filters shall be externally mounted and airflow shall tend to seal the filter to the cabinet structure. Location of filters shall provide free airflow.

0. Lighting fixtures shall not be used as connection boxes. A maximum of two (2) cables shall be connected per fixture for feed through only.
0. Provide labor, material and equipment to mark each new or modified cable with its circuit number and cable type by use of a raised-letter embossed aluminum tag wherever a cable enters an enclosure of any type or penetrates a deck or bulkhead. Cables shall have identification labels on each side of deck or bulkhead penetrations and at any other location where both sides of the penetration are not readily visible for cable tracing. Care shall be taken that the correct cable tag is installed on each cable and in every location where required. Assign a unique cable number to each separate piece of cable installed by the Contractor. For circuits that branch, or are connected at junction boxes, lighting fixture, etc., the basic cable number shall remain the same through the circuit. A bracketed dash number (-XXX) identifier shall be appended to each individual cable or wire starting with the lowest number at the power or signal source and increasing to the furthest load of the circuit. Provide new power/lighting typed panel directory cards for panels that have new or modified circuits. The circuit designation and load description of the circuit shall be typed on the card to correspond exactly with the final as-built condition of the Vessel.
0. Provide labor, material, and equipment to mark each individual wire for all new or modified circuits with identification floaters. Floaters will not be required for power or lighting cables. These floaters shall be provided and installed and be white polyolefin with permanent black typewritten lettering. The floaters shall be RAYCHEM-TMS (Terminal Marker System) or equal. Hand written letters or wire marker tape floaters will not be accepted. The correct circuit number shall be indicated on one line of each floater. On the second line of the floater, the terminal identification number shall be shown. The terminal identification number shall consist of the termination block and the termination point identification and the individual conductor identifier within the cable. Spare conductors and jumpers shall also be fully identified by this method.
0. Provide an identifying nameplate or label plate for each piece of new or modified electrical equipment, including junction and connection boxes, sensors, and all major components. Operators and indicators, either internal or external associated with this Work shall have label plates attached identifying the component and its function as part of the Work. Any special operating instructions or precautions that may be required by the new or modified system or equipment shall be included on the label plate or on a separate plate mounted adjacent to the equipment. Special operating instruction or precaution plates shall be worded, or otherwise identified, in a manner that will clearly

associate the instructions with the equipment or system to which they are affixed.

0. Unless otherwise specified or required by rule, regulation or law; nameplates, signs, labels, notices, and similar marking and devices shall be machine engraved phenolic laminate, brass, or stainless steel.
5. Phenolic laminate label plates shall be engraved no less than $\frac{1}{32}$ inch deep unless otherwise specified, on black back ground, with white letters, unless otherwise indicated on the Guidance Drawings. Metal engraved label plates shall be no less that 0.0875 inches thick, and engraving shall be no less than 0.04 inches deep filled with black enamel. Unless otherwise specified all lettering will be no less that $\frac{3}{16}$ inch high, block type letters and numbers. On switch escutcheons, lettering shall be no less than $\frac{1}{8}$ inch high. Labels shall match existing to the greatest extent practicable.
0. Wording shall be clear and concise with a minimum of abbreviation. Abbreviations, when necessary, shall be in strict accordance with ASME-Y14.38M, or MIL-STD-12, Revision E or later. The use of abbreviations is discouraged.
0. All label plates shall be attached using stainless steel screws, or WSF approved water and oil proof adhesives.
6. All control wiring terminations shall be made to terminal boards using ring lugs or wire compression caps under compression terminal connections. No termination shall be made using the bare wire end. Spade or fork type wire terminations shall not be acceptable. No more than two (2) wire terminators shall be placed under each screw of a terminal board exclusive of jumpers. Pin type terminal blocks shall use wire end thimble type sleeves, suitably sized. Bare stranded wire shall not be installed on any terminal strip without wire terminations installed on the wire.
0. All terminal lugs shall be installed using a manufacturer's approved controlled-cycle crimping device. All termination insulation shall be soft vinyl. Hard plastic insulating sleeves shall not be used.
7. Piping and/or tubing shall not be permitted in or on electrical cableway hangers, nor may they share deck or bulkhead penetrations.
8. Pop rivets shall not be used in place of threaded fasteners without the prior written approval of the WSF Representative, or are specifically called for in a Work Item. All exterior fasteners shall be Type 316 stainless steel. All interior fasteners shall be corrosion resistant, grade 5 or better. All nuts shall be Nylok or equal, except for general lighting and main cableways.
0. Test all new and modified electrical systems and components as required by Work Item TESTING and the Technical Specification.

BONDING

0. All electrical enclosures and/or equipment manufactured for electrically conductive material shall be electrically bonded (grounded) to the Vessel structure as follows:
 -) Bonding shall be achieved by use of flexible copper cable or strap. Bonding shall form a positive ground connection from the enclosure to the Vessel structure in accordance with 46 CFR 111.05-3;
 -) Bonding cables shall be installed using minimum length of cable and be consistent with, and meet Authoritative Agency requirements;
 -) All bonded cables shall be installed in locations that provide minimum exposure to possible physical damage and provide inspection, repair and replacement access;
 -) Bonding cables shall be attached to Vessel structure by a dedicated weld stud or weld pad and shall not be attached to pipe hangers, wireways, mounting hardware, or attachments;
 -) Bonded equipment shall include, but is not limited to, switchboards, transformers, electronics cabinets, battery chargers, transfer switches, lighting fixtures, motor starters, and receptacles. Electrical devices isolated by nonconductive bushings, boots, vibration isolators, and dampers shall also be bonded (grounded) to the hull. All equipment capable of generating static discharges shall also be bonded to the hull.

REUSE OF EXISTING CABLES

0. The Specifications and Guidance Drawings variously require new cable and the reuse of existing cable. In all cases where the use of existing cable is called for, the cable shall be tested as specified below.
0. All propulsion power cable to be reused shall be subject to a “high pot” test in accordance with IEEE-45.
0. All other cable shall be subject to an insulation resistance (megger) test. For these cables and wherever an insulation resistance (megger) test is called for, the test shall consist of:
 -) the use of a 500 volt “Megger” for circuits of 100 volts or greater and a 50 volt “Megger” for circuits of less than 100 volts;
 -) Measurement of the insulation resistance of each circuit between conductors and between each conductor and ground;
 -) For ungrounded neutral circuits, disconnecting the neutral from ground for the tests.

0. Minimum acceptable insulation resistance values shall be as defined in IEEE Standard 45-1998, Clause 8.13.3 for all existing cabling, and shall be 100 megohms minimum for all new cabling.
0. In cases where the reuse of cable is specifically required and the existing cable does not pass the test required above, the installation of new cable will be negotiated as set forth in the CONTRACT CHANGES provisions of the Contract.
0. In cases where new cable is specifically required and the condition of existing cable is such that reuse may be warranted, the Contractor may propose to the reuse of existing cables to the WSF Representative. If the Contractor desires to exercise this reuse option, he must conduct an insulation resistance test of the cable and present the results and the request to reuse the cable in writing to the WSF Representative. After review of the Contractor's request, the WSF Representative will approve or disapprove any such request, in part, or in full. All requests will be approved/disapproved on a "case by case" basis by the WSF Representative. Approval for reuse of existing cables in place of specified new cable will be negotiated as a "Deletion of Contract Work" as set forth in the CONTRACT CHANGES provisions of the Contract.

CABLE INSTALLATION

9. The Contractor shall develop Specifications for the quantity and type of cable to be installed to interconnect all equipment, as well as any other cabling required for new or modified systems. This cable shall be supplied and installed by the Contractor. When specifying interconnecting power and control cable types for installation, the Contractor shall use MIL-C-24643, Low Smoke cable. Armored cable shall only be used where it is specifically called for, otherwise, all cable shall be unarmored. All new power cable ampacity shall be designated for operating in a 50°C ambient environment and then de-rated to 80% of rated ampacity.
0. Cable may be double banked when de-rated as described above provided that a minimum air gap of one (1) cable diameter of the largest cable in a tier is maintained between adjacent tiers. All new and disturbed cable passing through fire boundaries requiring Structural Fire Protection Insulation shall be insulated for 12 inches (12 inch return) on the insulation side of the boundary to meet the requirements of USCG NVIC 9-97, and the Technical Specification.
0. Existing wireways shall be reused to the maximum extent practicable.
0. All new cable shall be subject to an Insulation Resistance Test in accordance with this attachment.
0. Provide cable based on actual identified loads. In no case shall the

cross-sectional area of any power distribution or lighting conductor be less than 4,000 circular mils. Non-power distribution conductors shall not be less than No. 18 AWG. All selected cables shall meet minimum fault current and maximum voltage drop limitations specified.

0. New or re-used cables with individual conductors of 6 AWG (23,000 circular mils) and larger, shall have both ends sealed with a flame resistant, waterproof sealer prior to final termination. Sealers shall be SIGMAFORM heat shrinkable boots, series FR, or equal.
0. New or re-used cables with individual conductors greater than 3/0 AWG (15,000 circular mils) and all new cables supplying distribution panels shall have the individual conductors fitted with tight fitting clear vinyl tubing the length of the exposed conductors and sealed with heat shrink tubing containing internal adhesive at both the crotch and cable ends of each conductor. On multiple conductor cables, the crotch end shall be fitted with a heat shrinkable crotch boot containing internal adhesive.
0. Cable sizes for new or reused existing cable shall be of sufficient size to ensure the maximum voltage drop from the ships service distribution switchboard to the furthest load does not exceed 6% of utilization voltage, and that the available fault current at the load is sufficient to assure proper clearing of circuit breakers and protection of installed cables against prolonged over current.
0. Extreme care shall be exercised during the installation of cable, wire and other equipment to ensure the external jacket of the cable or wire is not nicked, scraped, abraded, cut, burned, or otherwise damaged. Existing or new cable that is damaged in any way during the work shall be replaced in its entirety at no expense to the State and in accordance with the Technical Specifications. Splices are not permitted to extend or repair cables during the work.
0. Lugs on all new power distribution cable below the Main Deck shall be closed end type. Lugs shall be fitted with SIGMAFORM heat shrinkable tubing containing internal adhesive, SST/FR or equal, between the individual conductor insulation and the lug.
0. For main and local wireway modification the Contractor shall match existing wireways in type and quality to the greatest extent practicable. All fasteners shall be stainless steel. All exterior wire way clips and studs shall be stainless steel. WESSLER type cable supports and butterfly (quad) type pinch hangers shall not be used.
0. New interior cable hangers shall be steel with a corrosion resistant finish. Bolts, studs, nuts and washers shall be cadmium plated. If exposed, the fasteners shall be coated with a finish color appropriate to

the surrounding structure. All cables installed in horizontal wire ways shall be arranged so that if the cable retention device fails, the cable will remain supported by the hangers.

10. All new cable banding, and existing cable banding where disturbed, shall be stainless steel, $\frac{5}{8}$ inch wide \times 0.015 inch thick, using flexible channel rubber between the banding material and the cable jacket to prevent cable chafing. Unless otherwise specified, cable shall be installed in accordance with IEEE Standard 45-1998, Clause 10 and 33, and in accordance with 46 CFR 111.60. "Cable Splicing", as defined in IEEE Standard 45-1998, Clause 10.11, and 46 CFR 111.60-19, will not be permitted unless approved, in writing, by the WSF Representative. No non-metallic cable retention devices are allowed.
0. Banding shall be installed on all vertical hangers; on every third hanger, at a minimum, on horizontal runs; on the first hanger on each side of a collar, MCT (Multi-Cable Transit) or MCS (Multi-Plug System); on the first hanger on each side of a splice, and on the first hanger on each side of a turn and all hangers throughout the radius of the turn.
11. New or re-used cables shall not be installed in way of access cuts, hatches, and/or patches. The decision of the WSF Representative will be the final determination in questions pertaining to this matter.
0. New or re-used cables shall not be exposed to engine exhaust manifolds, exhaust piping, or other such sources of extreme heat. Where this is demonstrated to be unfeasible, appropriately insulated heat shields shall be provided.
0. New or re-used cables subject to mechanical damage by their location shall have appropriate mechanical protection provided. In high traffic areas, or other areas where cable may be damaged by door openings, equipment being moved, handcart traffic, and other similar circumstances, removable kick shields shall be provided to a height of no less than 24 inches above the deck.
0. New or re-used cables shall not be installed under or attached to gratings in the Engine Rooms, bilges, or other areas where they may be subject to oil damage. When it is absolutely necessary to run cables under gratings or walkways, they shall be installed on the underside of drip-proof pans or run through conduit. Metal pans shall be manufactured of no less than No. 14 gauge galvanized sheet metal. If cables are run through conduit, the cable ampacity shall be de-rated in accordance with National Fire Protection Association NFPA 70 "National Electrical Code".
0. All cable shall be run as directly as practicable, consistent with adequate ventilation of the cable wire ways and care to avoid

hazardous or otherwise undesirable locations. Cables shall not be installed adjacent to piping systems, machinery, or other sources from which leaks or other condensation may occur. Where such proximity is unavoidable, shielding manufactured of no less than USS No. 14 gauge galvanized sheet metal shall be provided, sectioned in lengths to allow convenient removal by hand.

- 0. Rat holes (snipes) and lightening holes shall not be used for cable routing under any circumstances.
- 0. Watertight connection boxes are permitted to extend existing cables for non-vital systems where allowed by the Guidance Drawings.
- 0. New cable penetrations through bulkheads, decks, and beams shall comply with Authoritative Agency requirements. Stuffing tubes for deck penetrations shall have kick pipes that are at least ten (10) inches high in the weather, and six (6) inches high in other locations, as measured from the top of the finished deck to the top of the pipe. The under deck side shall extend ½ inch beyond any thermal, structural, or acoustical insulation.
- 0. Where an MCT is required for a deck penetration, a watertight riser box shall be provided. The riser box shall be at least four (4) inches high, as measured from the top of the finished deck to the top of the riser box.
- 0. New cable shall utilize existing collars, Multi-Cable Transits (MCTs), and Multi-Plug Systems (MCSs) to the maximum extent possible. There shall be no penetrations made in structural members, except using approved multiple cable transits, without the prior specific written approval of the WSF Representative.
- 0. When existing MCTs or MCPs are disturbed by the Work, provide new blocks, packing and stay plates of the same manufacturer and type as existing. All existing blocks, packing and stay plates shall be removed as **Category “D”** material.
- 0. No more than two (2) new stuffing tubes shall be used in any location. In locations where stuffing tubes are used, the clear distance between adjacent stuffing tubes shall be no less than one and one half (1½) the diameter of the larger stuffing tube of the two. In locations where three (3) or more new cables penetrate a bulkhead or deck at the same location, MCTs or MCSs shall be utilized in lieu of “stuffing tube nests”. In locations where MCTs or MCSs are used, USCG approved multiple cable transits/ multi-plug systems as manufactured by NELSON, shall be utilized. Unless specifically sized differently in a Work Item, all multiple cable transits shall be provided with at least 20% spare capacity, and in no case less than one (1) spare, for cables of a similar size. When multiple cable transits are required through

and below the Auto Deck, they shall be of the radiused corner, marine frame, banded stress relieving type. Stuffing tubes, MCTs, and MCSs shall be continuously welded on both sides of the penetration.

NOTE: The use of sealers on MCT and MCS block contacts during assembly shall not be acceptable, except in the case of armored cable to block contacts.

NOTE: New cable penetrations, where required, shall be installed, insulated, and tested in accordance with USCG NVIC 9-97, "GUIDE TO STRUCTURAL FIRE PROTECTION" and this Technical Specification.

0. Cable tags shall be masked for painting. Care shall be taken that the correct cable tag is installed on each cable and in every location where required. The Contractor shall be wholly responsible for any expense incurred as the result of painted cable tag replacement, improper cable tag manufacturer, and for correction of any improperly installed cable tags.
12. Wiring identification floaters for cabling shall be provided for all wire terminations, except floaters are not required on power and lighting cables. Floaters shall be white polyolefin with permanent black typewritten lettering. The floaters shall be Raychem-TMS (Terminal Marker System), or equal. Handwritten or lettered floaters shall not be accepted and, if installed, shall be removed and replaced wholly at the expense of the Contractor. For all external cables each floater shall indicate the following: The correct circuit number shall be indicated on one side separated by a slash (/) with the individual conductor identifier within the cable; on the obverse side, a terminal identification number that matches the conductor identification given on the guidance drawings. Internal components and devices shall have wire floaters as follows:
 -) Each floater shall include the designation of the device (e.g. "K15") and the terminal number (marked on the device) where the wire is connected (e.g. "14"), for both ends of the wire. This includes spare wiring and jumpers, which shall also be fully identified.
 -) Systems requiring the use of identifying floaters shall have them included on point-to-point wiring diagrams as a part of the system drawings.
0. Color coding of cabling shall be accomplished using colored heat shrink vinyl, or no less than two (2) full wraps of ½ inch wide colored plastic tape. If colored tape is used for the markers, clear heat shrink tubing shall be installed over the tape to prevent its accidental removal. Individual circuits shall be colored as follows:

-) Three –phase, three-wire system, phases shall be coded:
A = BLACK, B = WHITE, C = RED.
-) Three-phase, four-wire systems shall be provided with tight fitting, phase-matching color-coded markers at each end to easily identify cables. Phases shall be coded: A = BLACK, B = RED,
C = BLUE with a WHITE neutral.
-) All ground connections, regardless of circular-mil size shall be marked GREEN.
-) For Direct Current circuits, positive shall be marked BLACK and negative shall be marked WHITE.

FIBER OPTIC CABLE

- 0. All new fiber optic cable installations, will be tested to the following requirements.
 - a) Test Equipment requirements. Optical time domain reflectometer (OTDR). The OTDR is used for estimating the attenuation rate of a fiber, and locating the nature and location of defects in an optical link.
 - b) Specified Limits. The cable is considered satisfactory if the maximum measured attenuation for each fiber does not exceed the vendor's attenuation data by greater than 1 db/km.
 - c) Acceptance/pre-installation tests. Fiber optic cable and associated components shall undergo visual inspection prior to installation in the cableways to verify that it is mechanically sound. Inspect fiber optic cable with OTDR to verify it is optically sound and within specified limits.
 - d) Installation tests. After the cable is installed in the cableways, the pre-installation tests shall be repeated to verify that fibers were not broken or damaged when the cable was pulled through the cableways.
 - e) Post-Installation tests. After all fiber optic cable topology links have been installed, tests using optical inspection with OTDR, shall be conducted to verify that the end-to-end attenuation of the fiber optic cable topology is within specified limits.

ELECTRONIC INSTRUMENT INSTALLATION

- 0. Temperature sensors for piping or tanks shall be mounted in thermowells.
- 0. Each transducer, RTD, and thermocouple shall have swivel or disconnectable leads.

- 0. Pressure transducers shall not be mounted on engines, vibrating structures, or sources. They shall be mounted in the vicinity of the local gage and be provided with test connection and shutoff valve to allow for transducer testing, a means for easy transducer replacement, and in general accordance with ASTM Standard F 721-81.
- 0. Snubbers shall be provided for pressure transducers that are connected to systems that are normally expected to experience rapid pressure changes or fluctuations and for locations indicating a need during testing and operation.
- 0. Each transducer for electronic instrumentation shall have a local gage or thermometer sensing and displaying the same function.

5. MECHANICAL INSTALLATION - PIPING

- . The Contractor shall provide design, labor, materials and equipment to install, modify, clean, and test all piping systems as set forth in the Technical Specification. Contractor is wholly responsible for the detailed design, fabrication, clearing of interference, modification, and installation and/or modification of all of the systems specified by the Technical Specification.
- . Unless otherwise specified by the Technical Specification, system design, material selection, installation procedures, and testing for all piping systems shall be as required by; 46 CFR §'s 56, 57 and 58, ASTM Standard F 1155-88, The World Health Organization (WHO) "Guide to Ship Sanitation", and United States Public Health Service (USPHS) "Handbook On Sanitation Of Vessel Construction", as is applicable to the Work. Should there be conflict between the requirements of the Technical Specification, ASTM Standard F 1155-88, and 46 CFR §'s 56, 57 and 58; the latter shall prevail except in the case of material selection, then the more stringent shall prevail.
- . Removals shall include pipe, valves, fittings, foundations, hangers, equipment, components, and all other similar items and devices that are not intended for reinstallation or reuse.
- . All new and modified piping system's design and placements shall permit:
 - 0. Easy access to valves and components for both operation and maintenance.
 - 0. Free passage along walkways and ladder ways.
 - 0. Free access to perform other system's operational and routine maintenance.
 - 0. Free access to all doors, hatches, ladders, openings, tank accesses, strainers, sea chests, treatment tanks, etc.
 - 0. Free access for the ready removal of Vessel equipment and system

components for inspection servicing, repair, and/or replacement.

- . Piping systems shall not pass through spaces predominantly equipped with electrical equipment unless directly associated with equipment installed in those spaces. When it is necessary to pass through or enter such spaces, piping shall not contain mechanical joints unless it can be demonstrated that the installation is impractical.
- B. Piping systems shall not pass directly above electrical switchboards, panels, disconnects, switches, motor starters, or Motor Control Centers. In no cases shall piping be routed over the EOS Control Console.
- . Provide pipe hangers in accordance with ASTM Standard F 708-92, Figure 1, Split Cap Hangers and as follows:
 - 0. All piping shall be adequately supported by hangers suitable for the material and service. "Piggybacking" of pipe hangers shall not be allowed unless specifically approved in writing by the WSF Representative.
 - 0. Hangers shall be continuously welded to the basic structure of the Vessel and shall not be welded to any pipe. Attachments to structural plate shall only be opposite from framing attachments. Care shall be taken to ensure that piping and hangers are of compatible material. Where dissimilar materials exist, hangers shall be isolated with a USCG approved isolation material.
- . Unless otherwise specified in the Technical Specification, piping penetrating decks or bulkheads shall be provided with tight fitting, extra heavy collars or sleeve fittings (similar to a coupling fitting as set forth in ASTM Standard F 682-82a, Type II), at all locations. All such sleeves or collars shall be fabricated with a vent hole, which shall be closed after all welding, brazing, and/or soldering is complete. Collars or sleeves shall be continuously welded to both sides of the structure. Pipes shall be continuously welded, brazed, or soldered, as appropriate, to both ends of the sleeve.
- . Existing piping or tubing installed in existing MP&E supplied transits shall not be disturbed. For piping or tubing no longer used, cut 12" from the transit on either side. Cap, plug or seal the 12" stub on both sides of the transit with suitable plugs or caps and paint red.
- . All piping penetrations through "B" and "C" type accommodation space bulkheads, as defined in USCG NVIC 9-97, shall be closed with tight fitting stainless steel faceplates.
- . Steam supply and refrigeration piping/tubing penetrating decks and/or bulkheads shall be thermally isolated from steel or aluminum plating by the use of a ROMAC or equal compression type coupling to prevent thermal loss from the system.
- . No pipe thread sealant tape shall be used on any fitting for final assembly.

- . Instrumentation piping system components and materials shall be selected, supplied, and installed in accordance with ASTM Standard F 721-81, and the Technical Specification. Control air, gage, and impulse tubing shall be minimum ¼ inch OD, Type 316 stainless steel.
- . Tubing and hose systems shall be designed and supplied utilizing PARKER Multi-Clamp Tube Clamping System, or equal, throughout the Vessel. Stacking will be permitted to conserve space, however, each tube or hose in a stacked system shall be clearly and permanently identified at intervals not to exceed twenty (20) feet and at least once in each compartment.
- . Valve operators may be installed under deck plating or grating levels. In these instances, the operators must be within six (6) inches of the deck or grating level, readily accessible, and labeled on deck level.
- . Handwheels for valves located below deck plates and gratings, except as noted otherwise in the Technical Specification, shall not extend through the deck plate or grating and create a tripping hazard.
- . Where remote or direct valve operators are installed under deck plating or grating, hinged access doors shall be provided to readily access the operators through the deck plates or gratings. Valve operators shall be free of interference through the entire cycle of their operation.
- . Where remote operators are required, rigid rod type remote valve operators manufactured by B.W. ELLIOTT MANUFACTURING CO. INC. or equal, shall be provided. Rigid rod type operators may be used in conjunction with universal joints up to a maximum of 30 degree offset. Gearboxes shall be used for offsets beyond 30 degrees. Where rigid rod cannot be used, flexible shaft type remote valve operators manufactured by B.W. ELLIOTT MANUFACTURING CO. INC. or equal shall be provided.
- . Drains from equipment shall not be less than ¾ inch IPS.
- . The affects of di-electric corrosion and corrosion by erosion shall be taken into consideration for all piping design, supply, and installation Work.
- . Flange gaskets shall be GARLOCK Blue-Gard 3300 in water and steam service and GARLOCK Blue-Gard 3000 in fuel, lubricating, and hydraulic oil service. All gasket material shall be certified asbestos free.
- . The use of Association of American Railroad (AAR) fittings in lieu of Extra Heavy 300 pound malleable iron fittings is prohibited.
- . Flexible hose shall be certified to SAE J1942 unless directed otherwise in the Technical Specification. All flexible connections shall be fabricated using AEROQUIP FC-234 AQP hose for sizes less than one (1) inch and AEROQUIP 2651 hose for sizes one (1) inch and above on fuel and lube oil systems; and AEROQUIP 2651 hose on all other systems, except high pressure hydraulic steering hoses which shall be AEROQUIP type currently certified to SAE J1942 for the intended service. All hose assemblies shall be

fabricated using AEROQUIP reusable fittings. Hose fittings shall be certified to SAE J1475.

- . During the fabrication, installation and testing of all piping systems, openings shall be kept tightly sealed to insure foreign matter and moisture exclusion. This includes components such as valves, pumps, coolers, heaters and instruments. Tape alone or the use of wood blanks is not an acceptable means of foreign matter and moisture exclusion. Use metal or plastic caps, plugs and blanks, or metal plugs and gags as appropriate to limit system and component contamination.
- . All piping and tubing must be mounted without springing or forcing into place. Flange faces shall be parallel (plus 1/32 inch, minus 0) before bolting. All pump face to flange fit up shall be demonstrated to the WSF Representative prior to final bolting.
- . Provide flanged takedown joints in piping 2-½ inch and over and unions in piping 2 inch and under, unless specifically directed otherwise by the Technical Specification. Flanges in piping shall conform to ANSI Standards for the appropriate service.
- . Where a steel flange is used with a cast iron or bronze flange, the steel flange shall have a flat face and a full-face gasket shall be used.
- . Piping and/or tubing is not permitted in or on electrical cableway hangers, nor may they share deck or bulkhead penetrations.
- . Screwed plugs or caps shall be bronze for either ferrous or non-ferrous materials.
- . Pipe runs shall be designed to be as direct as possible, with as few bends, elbows and tees as practicable.
- . Pipe and tubing machine bending processes shall be used wherever possible, unless specified otherwise in the Technical Specification, or by having been satisfactorily demonstrated to and approved by the WSF Representative that the use of elbows is more practical at a particular location(s).
- . To accomplish change of direction, machine bend pipe and tube to a minimum radius of five (5) times the nominal pipe diameter for pipe two (2) inches IPS and below, and Cu-Ni tube. Stainless steel tubing may be bent to a radius of five (5) times the nominal tube diameter. Copper tubing may be bent to a radius of three (3) times the nominal tube diameter.
- . Control air, gauge, and impulse tubing may be hand bent or machine bent to a radius of five (5) times the nominal diameter. Hand bending tube without the use of an appropriately sized tubing bender is prohibited.
- . Pipe welding and brazing shall comply with the rules and regulations of all applicable Authoritative Agencies, such as 46CFR § 57 and the details of ASTM Standard F 722-82.

- . Mitred joints or fittings are prohibited.
- . Unless otherwise specified, ferrous pipe with welded fittings, which are required to be galvanized, shall be Hot-Dip galvanized after fabrication. Where galvanizing is damaged during installation, GALVICON or equal, brush-on galvanizing coating shall be applied to the damaged areas after appropriate surface preparation.
- C. Pop rivets shall not be used in place of threaded fasteners without the prior written approval of the WSF Representative, unless specifically called for in a Work Item. All exterior fasteners shall be Type 316 stainless steel. All interior fasteners shall be corrosion resistant, grade 5 or better. All nuts shall be Nylok or equal, except for general lighting and main cableways.
- . All new or modified piping, piping appurtenances, and associated equipment shall be thoroughly cleaned after fabrication and prior to installation in the Vessel. After installation, each new or modified system shall be thoroughly cleaned and flushed of all foreign material utilizing the normal system medium or a WSF approved substitute.
- . FLUID DESIGN VELOCITIES
 1. Fluid velocity criteria given in Table, FLUID DESIGN VELOCITIES, shall be used in sizing each associated piping system designed by the Contractor.

FLUID DESIGN VELOCITIES

Type of Service	Nominal Pipe Diameter (in)	Maximum Velocity (fps)
Fuel Oil Suction	$2 \times \text{SQRT}(D)$	7
Fuel Oil Discharge	$5 \times \text{SQRT}(D)$	12
Lubricating Oil Suction	$1 \times \text{SQRT}(D)$	4
Lubricating Oil Discharge	$2 \times \text{SQRT}(D)$	6
Steam	$50 \times \text{SQRT}(D)$	150
Condensate Drains	$0.3 \times \text{SQRT}(D)$	1
Sea Water Suction	$3 \times \text{SQRT}(D)$	**
Sea Water Discharge	$5 \times \text{SQRT}(D)$	**
Freshwater Suction	$3 \times \text{SQRT}(D)$	15
Freshwater Discharge	$5 \times \text{SQRT}(D)$	20

Where: (D) = pipe internal diameter in inches

** = 9 fps for galvanized steel and 9 fps for CuNi pipe except for occasional use service systems

0. Flow turbulence shall be minimized by:
 -) Restricting the velocities to within the specified limits
 -) Elimination of abrupt changes of pipe diameters in piping runs and connections
 -) The incorporation of gradual transitions in diametrical changes
 -) The use of long-radius bends and fittings
 -) Using swept tees, wyes, and lateral type fittings wherever possible

System piping and associated components shall be designed to provide adequate flow to all equipment served. The use of automatic regulators, orifices or other restrictive devices in lines servicing auxiliary components, such as heat exchangers, are permissible for obtaining and maintaining operational conditions. These devices however, shall not impose undue restrictions, such as large pressure drops or create destructive erosion conditions.

- . Orifices, where required, shall be incorporated at flanged joints. The use of orifices is not encouraged, proper sizing of piping systems is the design preference; however, If they are used they shall be installed where there is a straight run of pipe 8 to 10 diameters in length downstream of the orifice before there are any bends. The design and installation of orifice plates shall be such that a tab or handle protrudes visibly beyond the incorporating flanged joint and any associated insulation. The orifice size shall be stamped with ¼ inch high letters on the tab or handle. Pan handles shall be fabricated long enough so that the handle lettering extends out beyond the finished insulation.
- . Pipe runs shall be designed to be as direct as possible, with as few bends, elbows and tees as practicable. Bends shall be used in place of elbows wherever possible. Where tees are used, they shall be arranged so that the flow enters the end and exits through the middle, there shall be no "bull heading".
- . All new piping system's design and placements shall permit:
 - 0. Easy access to valves and components for both operation and maintenance.
 - 0. Free passage along walkways and ladder ways.
 - 0. Free access to perform other system's operational and routine maintenance.
 - 0. Free access to all doors, hatches, ladders, openings, tank accesses, strainers, sea chests, treatment tanks, etc.
 - 0. Free access for the ready removal of Vessel equipment and system components for inspection servicing, repair, and/or replacement.
- . Diesel fuel systems shall be located at least 18 inches away from surfaces which have temperatures under their insulation or lagging in excess of 450°F. Lubricating oil systems shall be located at least 18 inches away from surfaces which have temperatures under their insulation or lagging in excess of 650°F. Hydraulic oil systems shall be located at least 18 inches away from surfaces which have temperatures under their insulation or lagging in excess of 650°F.
- . All piping penetrations through "B" and "C" type accommodation space bulkheads, as defined in Reference (F), shall be closed with tight fitting stainless steel face plates.
- . All removals shall be cut back to the structural attachment point leaving about one quarter of an inch of material which shall ground down and prepared for painting in accordance with the WSF Marine Coatings Standard and the Contract Specification.
- . During the fabrication, installation and testing of all piping systems, all pipe, valve, and other system component openings shall be kept tightly sealed to insure foreign matter and moisture exclusion.. Acceptable methods of sealing are metal or plastic caps, plugs and blanks, or metal plugs and gags.

- . All piping and tubing must be mounted without springing or forcing into place. Flange faces shall be parallel (plus 1/32 inch, minus 0) and in line before bolting. All pump face to flange fit up shall be demonstrated to the WSF Representative prior to final bolting.
- . Flanged takedown joints in piping 2½ inch and over and unions in piping 2 inch and under shall be provided, in accordance with the Technical Specification.. Flanges in piping shall conform to ANSI Standards for the appropriate service.
- . Where a steel flange is used with a cast iron or bronze flange, the steel flange shall have a flat face and a full face gasket shall be used.
- . All threaded CuNi nipples shall be fabricated from 90-10 material, Schedule 40 pipe. Butt welded end of nipples shall have their inside diameters tapered to suit Class 200 CuNi. Special care, such as the proper thread cutting oils, shall be exercised when threading CuNi nipples.
- . Piping systems shall not be installed over major machinery or equipment unless unavoidable. In all cases where such piping runs are unavoidable, suitable isolation valves and mechanical takedown joints shall be provided to allow for the removal of machinery, equipment, and system components.
- . No piping or takedown joints shall be installed over the main propulsion motors, soft patches, access hatches, sea chest covers, sea water treatment tank accesses, or strainers.
- . Provide expansion bends sufficient to accommodate piping movement due to thermal expansion. Steam supply and condensate return piping shall be provided with at least one (1) expansion bend in each compartment that it passes through to accommodate thermal growth. Expansion joints shall not be used in lieu of expansion bends.
- . Pumps shall be installed with positive suction; either through submergence, foot valves, or priming systems to insure immediate and positive pump operation.
- . Discharge piping connected to self-priming pumps shall be installed to rise vertically not less than 30° from the horizontal plane to permit self venting of air or gas.
- . All pumps shall be provided with suitable piping takedown fittings to allow for easy service removals.
- . HANGERS
 - 0. All piping shall be adequately supported by hangers suitable for the material and service. “Piggybacking” of pipe hangers, unless specifically approved otherwise by the WSF Representative, shall not be allowed.
 - 0. Provide pipe hangers in accordance with ASTM Standard F 708-92,

Figure 1, Split Cap Hangers. ASTM Standard F 708-92, Figure 7, Nelson type hangers may be used for piping one and one half inches and below. All hangers provided shall be designed for the dynamic loading imposed by the operating conditions described in the Technical Specification, and to prevent damage from vibration and thermal expansion.

- 0. All hangers shall be lined with a resilient material suitable for the temperature of the system served. Bolting shall be Type 316 stainless steel, with self-locking nuts.
- 0. Hangers shall be continuously welded to the basic structure of the Vessel and shall not be welded to any pipe. Attachments to structural plate shall only be opposite from framing attachments. Care shall be taken to ensure that piping and hangers are of compatible material. Where dissimilar materials exist, hangers shall be isolated with a USCG approved isolation material.
- 0. Stand-off configuration may be single leg, dual leg, or chair type as applicable for specific piping size and hanger attachment location.
- 0. All non-ferrous piping which passes through fire boundaries shall be supported so that if the solder or brazing material melts, the piping cannot sag or shift, opening a joint which would allow passage of smoke or flame through the boundary in accordance with Reference (F.).
- 0. Valves 2½ inch and above shall be individually supported from the Vessel structure.

DRAIN SYSTEM DESIGN and INSTALLATION REQUIREMENTS

- 0. Route drain piping as direct as possible. Sanitary and other drain system piping shall be designed and/or installed with readily accessible 1½ inch IPS clean-out caps/fittings suitable for use with a plumber's snake or pressurized water hose and in sufficient number to ensure clear access to each run of pipe from at least one end. Caps shall be of a compatible material, or bronze. Clean outs shall be installed in the direction of flow of the system media, be of sufficient length so as to extend beyond the installed pipe insulation coverings and be located to allow easy accessibility and thorough cleaning of the system. There shall be no clean-out connections installed or provided within any food service/preparation areas.
- 0. All plumbing fixture drains shall be independently trapped.
- 0. Use long radius and sweep type fittings for all drains serving toilet fixtures.
- 0. Branch connections to athwartship drains which discharge to both sides of the Vessel shall be made at 90 degrees using double sweep

fittings.

0. Where drains are combined, either wye or sweep tee fittings shall be used to facilitate flow.
0. Soil drains and interior deck drains shall be kept independent of weather deck drains. When combining soil drains with other interior deck drains, connect the deck drain in the vertical drop of the soil drain with a twelve (12) inch water trap to prevent the escape of odors. Soil drains or deck drains combined with other drains located on upper deck levels shall join at least four (4) feet below the lowest drain to prevent back flooding under design conditions of list, trim, roll, or pitch of the Vessel. Combined drains shall be collected by groups into mains and lead to the existing sewage holding tank. Drains shall be installed with a pitch of not less than $\frac{1}{4}$ inch per foot longitudinally and $\frac{1}{2}$ inch per foot transversely unless otherwise specified.
0. Interior deck drains servicing any food preparation areas shall be run independently and shall not be combined with soil drains.
0. All food service machine drains shall not be smaller than $\frac{3}{4}$ inch IPS. Provide quick opening disconnect to all food service machine drain lines.
0. Deck drains shall be fitted with removable brass strainer plates having a free area equal to no less than twice the cross-section of the drain pipe. Strainers shall be flush with the finished deck and properly secured with brass or stainless steel fasteners as applicable.
0. Slope piping in each system to drain naturally to the low end.
0. Systems having unavoidable low points and/or pockets, which may be affected by freezing temperatures or where trapped water may be detrimental to the operation of the system or system component, shall be provided with either flanged or bossed drainage fittings. Plumbing traps shall not, unless unavoidable, be installed in locations where the trap could freeze. Provide such trap installations with freeze protection insulation.
0. Drainage points required during start-up, and/or requiring manual drainage while in service, shall be provided with valved drains. Other points requiring infrequent drainage in conjunction with maintenance, dry-docking and periodic inspection may be provided with screwed plugs. All low points or pockets in the firemain system shall be provided with valved and capped drains.
0. All low points or pockets subject to weather in the Vehicle Deck sprinkler systems, shall be provided with $\frac{1}{8}$ inch diameter drain holes drilled in the bottom of the tubing or pipe low points.
0. Screwed plugs or caps shall be bronze for either ferrous or non-ferrous

materials (except for aluminum drain pipe, which shall use a DWV plug). Plugs exposed to sea water shall be Monel.

- 0. Install all deck drains so that the camber of the deck will lead water to each drain.
- 0. All drain piping to funnel drains shall have their air gap end cut at a 45 degree angle.

TUBING

- 0. Steam supply and refrigeration piping/tubing penetrating decks and/or bulkheads shall be thermally isolated from steel or aluminum plating by the use of compression type coupling to prevent thermal loss from the system.
- 0. Stainless steel tubing may be bent to a radius of five (5) times the nominal tube diameter. Copper tubing may be bent to a radius of three (3) times the nominal tube diameter. Tubing and hose systems shall be supported at intervals of not less than four (4) feet throughout their length. Stacking is permitted utilizing multi-clamp tubing systems provided the spatial relationship of each tube is preserved between clamps. Each tube or hose in a stacked system shall be clearly and permanently identified at intervals not to exceed twenty (20) feet and at least once in each compartment.

FLEXIBLE CONNECTIONS

- 0. Piping connected to rotating and reciprocating machinery and resiliently mounted equipment shall have flexible connections provided which are located as close to the machinery/equipment as is possible.
- 0. Except where specifically otherwise noted, all hose assembly end connections shall be; flanged for sizes two (2) inches and above, with SAE 37° (JIC) flare swivel nuts on each end for sizes under two (2) inches.
- 0. Diesel oil system flexible connections shall be selected and installed as required by 46CFR § 56.60-25 with SAE 37° (JIC) flare swivel nuts on each end.
- 0. All flexible connections shall be designed and fabricated in standard lengths in accordance with 46CFR 56.60-25(b)(4) with end connections to facilitate spares interchange-ability within system applications. Identify all flexible connections with metal tags which identify Manufacturer, Size, Model, Date of Manufacture, and Material.

WELDING AND BRAZING

- 0. Pipe welding and brazing shall comply with the rules and regulations of all applicable Authoritative Agencies, such as 46CFR § 57; the

details of ASTM Standard F 722-82 (1988); F1076 (1992); and the WSF Structural Installation Standard. Welding performance and procedure qualifications shall meet the requirements of 46CFR57.01 through 57.05-3.

- 0. Butt welding of piping shall only be allowed on 2½ inch nominal and above.
- 0. Mitered joints are prohibited.
- 0. Brazing temperature shall not exceed the annealing temperature of the base pipe material, and in no case shall the brazing temperature range exceed 1300-1500°F for 90-10 copper nickel pipe and tubing. The Contractor shall employ the use of temperature indicating crayons (Temp. Sticks) to assure that the maximum temperature as stated above is not exceeded.
- 0. All soldering of copper pipe or tubing joints shall be accomplished using 95-5 Tin-Antimony solder materials in accordance with ASTM Standard B32.

CORROSION PROTECTION DESIGN and INSTALLATION REQUIREMENTS

- 0. The affects of dielectric corrosion and corrosion by erosion shall be taken into consideration for all piping design, supply, and installation work.
- 0. Dielectrically isolate any contact combination between steel, CuNi, and aluminum materials.
- 0. Except resilient-seated butterfly valves and other approved lined or liner type valves and fittings, all valves and fittings in non-ferrous piping runs shall either be bronze or of a material comparable to the piping material.
- 0. Whenever ferrous to non-ferrous joints are specified for pipe sizes 2½ inch and above, a flanged joint shall be provided between the dissimilar metal pipes. The flanges shall be dielectrically isolated from one another through the use of flange insulation kits. Whenever ferrous to non-ferrous joints are specified for pipe sizes below 2½ inch a dielectric union shall be provided between the dissimilar metals. Whenever a non-ferrous pipe connects to a ferrous pipe which has a diameter two (2) or more times larger than that of the nonferrous pipe insulation kit or dielectric union are not required, unless specified in the Technical Specification.
- 0. Unless otherwise specified, ferrous pipe with welded fittings which is required to be galvanized, shall be Hot-Dip galvanized after fabrication. Where galvanizing is damaged during installation, brush-on galvanizing coating shall be applied to the damaged areas after

appropriate surface preparation.

0. Where galvanized screwed fittings are required, both galvanized piping and fittings shall be used. Exposed threads that have not been galvanized, shall be treated with brush-on galvanizing coating system.
0. Sea water treatment tank connections shall have a grounding strap provided for dissimilar metal joint transitions.

CLEANING, FLUSHING, AND DISINFECTION

0. All new or modified piping, piping appurtenances, and associated equipment shall be thoroughly cleaned after fabrication and prior to installation in the Vessel. After installation, each new or modified system shall be thoroughly cleaned and flushed of all foreign material utilizing the normal system medium or a WSF approved substitute.
0. Internal surfaces of newly fabricated fuel oil, lube oil, and hydraulic fluid piping shall be cleaned by acid pickling, then oiled to prevent corrosion. After piping systems have been pickled and oiled, all open ends shall be sealed. System cleaning shall be accomplished using Contractor furnished flushing machines and heaters capable of circulating system fluids. The Reynolds Number for the flowing condition during flushing shall be greater than 4000 to insure that the flow is turbulent.

Reynolds number is the product of **Fluid Velocity**, (V in ft./sec.) and the pipe **Inside Diameter**, (D in ft.) divided by the **Kinematic Viscosity**, (v in ft.²/sec.). Normally kinematic viscosity is given in units of Centistokes. To convert Centistokes to ft.²/sec, multiply Centistokes by 0.0000176 (1.076x10⁻⁵)

$$Re = \frac{V D}{v}$$

0. During flushing of ferrous piping, the complete piping system, along its full length, shall be continuously vibrated using pneumatic or electric motor driven line vibrators of the temporary in-line type, which shall be firmly affixed to the piping throughout the cleaning cycle. Temporary jumpers shall be installed so that all portions of the system are flushed.
0. Hydraulic oil, fuel oil and lube oil systems shall be flushed in accordance with the Technical Specification. In the event no flushing procedure is specified the following guidance is to be followed: Pumping shall be accomplished using Contractor furnished pumps. Fit temporary strainers in systems while systems are being flushed.

Temporary strainers shall be lined with ten (10) micron filter bags with magnets, and shall be inspected every two (2) hours during flushing activities. Clean temporary strainers periodically while changing filter bags, and continue flushing until fluid is clean in accordance with Reference (J.) to NAS Class 8 or better.

0. Before placing the potable water system in service, it shall be first soaked and flushed to remove flux, and subsequently be cleaned, disinfected, flushed and certified in accordance with the "The World Health Organization (WHO) Guide to Ship Sanitation", and United States Public Health Service (USPHS) "Handbook on Sanitation of Vessel Construction". Should it be necessary to reopen the potable water system prior to redelivery of the Vessel, the entire system shall be re-cleaned and re-disinfected, with a new Certificate of Disinfection provided to the WSF Representative.

6. MECHANICAL INSTALLATION - VENTILATION

- . Vent ductwork installations shall be hot dipped galvanized sheet steel. Touch up all damaged or destroyed galvanizing with approved cold galvanizing compound after fabrication.
- . All vent ductwork shall be smooth inside with no protruding edges. Ducts shall have riveted, welded, or hooked seams. Rivets shall be of minimum length required to seal seams.
- . Bends and elbows in vent ductwork shall be fabricated with a throat radius of at least $\frac{1}{2}$ times the diameter or width. Where this is not possible due to space limitations, a vaned turn or splitter shall be used to give quiet and efficient operation.
- . Reductions in vent ductwork size shall be accomplished with transition pieces. Converging transition pieces shall have a maximum 30° included angle. Diverging transition pieces shall have a maximum 15° included angle. If the transition angle exceeds the above requirements, splitters shall be fitted to reduce the expansion angle.
- . Ventilation ductwork may be round, flat oval, or rectangular. The minimum thickness of ventilation duct material shall be in accordance with the following Table, unless otherwise specified. The size is determined by the diameter for round duct and the maximum dimension for rectangular or flat oval duct.

VENTILATION DUCT THICKNESS REQUIREMENTS		
SIZE	THICKNESS INCHES	
	STEEL	ALUM
Less than 12 inches	0.030"	0.040"
12.5 to 18 inches	0.036"	0.050"
18.5 to 30 inches	0.048"	0.060"
Above 30 inches	0.060"	0.080"
Exposed duct, weather decks, areas subject to mechanical damage	0.060"	0.080"

- . Install ductwork tight to overhead deck beams. Routing of overhead ductwork shall not violate headroom space.
- . All joints in the ductwork shall be sealed airtight with a USCG approved fire resistant, high velocity duct sealer.
- . Diffusers and grilles shall be selected on the basis of Noise Criteria (NC) Curves acoustical design criteria. Diffusers and grilles shall be selected to meet the criteria of NC-35 or less.
- . Provide adjustable system balancing dampers in all branch supply, return, and exhaust ductwork.
- . All ductwork shall be properly supported from Vessel primary structure with vent duct supports and hangers shall be insulated from the duct with cloth inserted neoprene rubber.
- . All Vessel and/or equipment ventilation and piping systems that are provided new, modified, or relocated by the Contract Work shall have all associated components, equipment, ductwork, dampers, diffusers, operators, pipes, valves, and appurtenances labeled to match the existing system labeling methodology.

Test all new and modified piping and vent systems and components as required by Work Item TESTING and the Technical Specification.

7. GAGING AND THERMOMETERS

DIRECT READING PRESSURE AND VACUUM GAGES

2. Cases for gages shall be brass, aluminum, or molded phenolic, generally 100 mm or 4 ½ inches in diameter. Gages in consoles or part of gage boards shall be flush-mounted. New gages on incidental local boards may be flush or surface mounted, and silicon filled. Dials shall have black markings on dull aluminum, silver, or white background, with graduations covering an arc of not less than 270°. Pointers shall be shaped to permit reading to an accuracy of at least the smallest division of the scale on the instrument. Each gage shall have a red pointer to be set at the normal pressure. Select each gage's scale so the normal operating pressure will be in the middle one-third ($\frac{1}{3}$) of the scale range and so that the maximum system pressure does not exceed the scale range.
3. Each pressure gage shall have a ball valve, similar to WHITEY #S-IRF4, and a test tee with a plugged branch connected directly to the gage. The connection of the gage line to pipe or machine shall have a second valve if the gage is not mounted directly on the pipe or machine. Provide a snubber in any gage line where needle fluctuation cannot be damped by throttling the gage valve. All gage tubing shall be $\frac{1}{4}$ " or $\frac{3}{8}$ " OD stainless steel tubing as appropriate. Unless otherwise listed or specified, the graduation of the dials shall be as listed in the following Table

		Gage Scale		Smallest Scale Division	
Service	Vacuum (in. Hg)	Pressure (psi)	Vacuum (in. Hg)	Pressure (psi)	
Vacuum	30	--	0.5	--	
Compound	30	30	1	1	
Compound	30	100	5	1	
Compound	30	150	5	1	
Compound	30	300	--	5	
Pressure	--	60	--	1	
Pressure	--	100	--	1	
Pressure	--	200	--	2	
Pressure	--	300	--	5	
Pressure	--	400	--	5	
Pressure	--	1500	--	10	

ELECTRONIC PRESSURE GAGES

0. The electronic pressure meters required by the Contract Work shall have an analog display. The display shall cover about 270° of arc. Scales shall be in pounds per square inch (psi). Select each scale similar to that for a direct reading pressure gage. Meters shall be YOKOGAWA D-C Ammeter Type DB or equal with external linear adjustment.
0. Provide a pressure transducer for each electronic gage, with a 4 to 20 mA DC linear output, proportional to pressure, to the meter. Transducers shall have NEMA 4 or 12 enclosures. Connect each transducer to its piping system in the same manner as required for direct reading gages, including ball valve and test tee. The connection may be a branch from the local, direct reading gage piping. Provide a damper in the fuel oil pressure gage line as specified by the engine manufacturer.
0. Transducers to the main engine connection points requires mounted cut out valves in lieu of the existing arrangement. Provide brackets and panel mount cut out valves and test tees at the main engine connection point. The valves will provide simultaneous cut outs for both the transducers and pressure switches. Provide a power supply fed from the emergency lighting system to supply excitation voltage for the pressure transducers in each group as required by these Specifications.

THERMOMETERS

4. Direct reading thermometers shall be dial type. Thermometers mounted directly on pipe shall be bimetallic type with 3-inch dials. Thermometers mounted on local gage boards shall be gas or vapor filled with 4½-inch cases, duplicating pressure gage cases. All thermometers shall have dry wells with ¾-inch standard pipe threads. They shall be brass for temperatures of less than 450° F, except for those used with oils, which shall have steel sockets, and those used in salt water, which shall have Monel sockets. Indicator dials for thermometers with a range to 250° F or less shall have graduations at least every 2° F with figure intervals of not more than 20° F. Dials reading over 250° F shall have graduations at least every 5° F with figure intervals not more than 50° F. Dial ranges shall be selected so that normal operating temperatures shall be not more than 75 percent of the scale range.

SPARES

0. Furnish spares for Contractor furnished instruments as follows:

<u>Qty</u>	<u>Description</u>
1	Direct reading pressure gage for each range installed
1	Direct reading thermometer for each type and range installed
1	Electric pressure gage for each type and range installed
2	Pressure transducer, each range

8. MIMIC BOARDS

Mimic boards shall be made with Photo Process that laminates the mimic diagram between two (2) layers of LEXAN.

END OF ATTACHMENT